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MISSION-CREW FATIGUE DURING RIVET JOINT OPERATIONS.(U)
SEP 76 W F STORM, J D HAPENNEY

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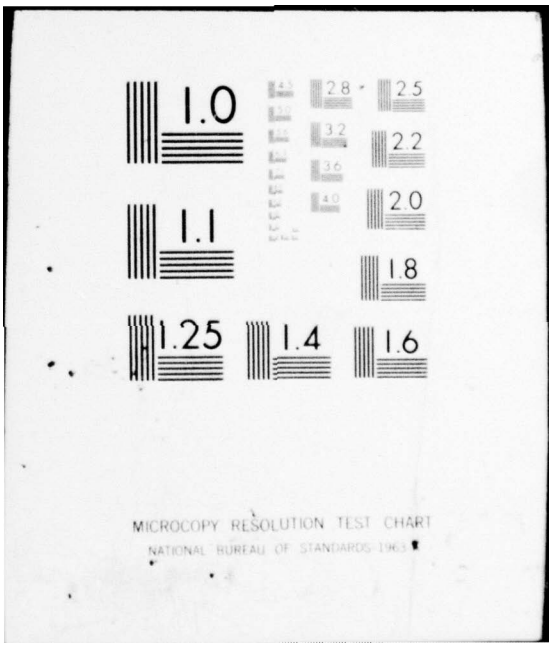
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MISSION-CREW FATIGUE DURING RIVET JOINT OPERATIONS

September 1976

Preliminary Report for Period February-July 1976

USAF SCHOOL OF AEROSPACE MEDICINE
Aerospace Medical Division (AFSC)
Brooks Air Force Base, Texas 78235

NOTICES

This final report was submitted by personnel of the Crew Performance Branch, Environmental Sciences Division, USAF School of Aerospace Medicine, Aerospace Medical Division, AFSC, Brooks Air Force Base, Texas, and USAF Security Service, Kelly Air Force Base, Texas, under job order 7930-09-11.

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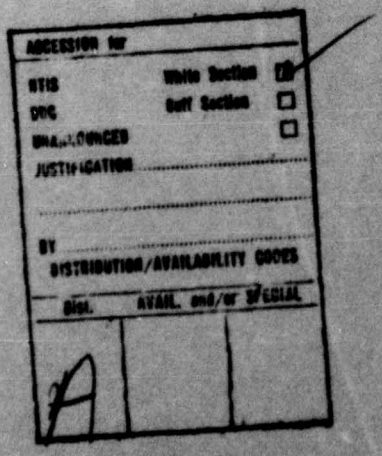
This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

William F. Storm
WILLIAM F. STORM, Ph.D.
Project Scientist

Bryce O. Hartman
BRYCE O. HARTMAN, Ph.D.
Supervisor

Robert G. McIver
ROBERT G. MCIVER, Colonel, USAF, MC
Commander



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Subjective fatigue and sleep data were collected from a USAF Security Service airborne mission team before and during an airborne mission. The primary purpose of the test was to refine the procedures and analytical techniques in preparation for an upcoming demonstration/evaluation of a new and modernized system. Results indicated that only minor changes in procedures and techniques were necessary. The data also provide unique baseline information for future comparison and evaluation of similar data from the modernized system.

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MISSION-CREW FATIGUE DURING RIVET JOINT OPERATIONS

The Crew Performance Branch (VNE) of the USAF School of Aerospace Medicine (SAM) has been requested to assist in the human factors evaluation of the new system operated by USAF Security Service personnel onboard a RIVET JOINT aircraft. The system is comprised of electronic surveillance equipment and is being modernized to include computers and other state-of-the-art apparatus in order to improve manpower utilization. One of the five specific human factors test items is to "determine the psychological and physiological stresses upon the mission team due to environmental conditions and interaction with the system." USAFSAM/VNE has been conducting research on the psychobiologic effects of operational stress and fatigue for well over a decade (1-4). A test procedure using the SAM stress battery has been written as part of the overall demonstration/evaluation program. The stress battery includes endocrine/metabolic measures analyzed from urine samples, sleep logs, and subjective fatigue questionnaires. These measures have been consistently sensitive to mission effects and have provided a solid foundation for recommendations regarding operational procedures.

In June 1976, an opportunity occurred to collect some preliminary behavioral data from mission teams using the current RIVET JOINT system and flying the same routes as will the test missions of the modernized system. As it is always desirable to "debug" and improve techniques used in test and evaluation programs, this opportunity was welcomed.

METHOD

Subjective fatigue data (SAM Form 136) and sleep logs (SAM Form 154) were collected from a typical 22-man mission team during the flight. The mission started at 0500 and terminated at 1600, local time, and was conducted on an RC-135 flown by Strategic Air Command. The crewmen had been in the local area for at least several weeks and were, therefore, adapted to the local time zone. A preflight data sample consisting of mission-crew responses to both questionnaires was collected at 0200 during check-in and premission briefings. At 0600 (1 hour after takeoff) and then at 3 hour intervals (0900, 1200, and 1500), each crewman completed a subjective fatigue questionnaire. If a crewman was very busy, he was not disturbed for data collection; 7 of the crewmen missed one data collection time, and 2 others missed two data collection times. The sleep log was completed by 21 of the 22-man mission team. The questionnaires were administered by one of the authors (JDH). Urine samples were not collected because inflight storage facilities were not available on this mission.

RESULTS

A summary of the findings is presented in Table 1. On the average, the crewmen slept 7.3 hours during the 20-hour period (0600-0200) preceding preflight check-in. While this is a typical sleep duration, it is notable that some crewmen slept as much as 10 and 14 hours during this period, and others as little as 3 and 5 hours. The longer duration sleep times were usually acquired in two separate sleep periods, with a few hours wakefulness between them. A closer inspection of the "hours slept" data concentrated on the duration of the last continuous sleep period before mission check-in. This analysis resulted in a mean sleep time of only 4.5 hours. With little variation, average awakening time was at 2400, local time. Most of the crewmen encountered moderate difficulty in going to sleep, awakened only slightly to moderately rested, and felt they could have used more sleep.

The subjective fatigue checklist provides a quantitative score from 0-20, with lower scores indicating feelings of greater fatigue. The RIVET JOINT scores revealed increased feelings of fatigue as the mission progressed from preflight check-in to termination. A 2-way analysis of variance, which allowed for missing data, indicated this progressive increase in fatigue to be statistically significant ($P < .002$). The mean fatigue scores (calculated to adjust for missing data) for each data collection time were: 10.4 at 0200; 9.5, 0600; 9.0, 0900; 8.0, 1200; and 7.5, 1500. Scores of 9-10 have been found to represent mild fatigue. Previous studies have shown that complete recovery normally follows an 8-hour sleep period when fatigue is at this level. Scores of 7-8 suggest moderate psychological and physiological cost, and 8 hours of sleep may not be sufficient for complete recovery.

DISCUSSION

The operational significance of the RIVET JOINT subjective fatigue data can be evaluated by comparison with established baseline values and similar operational data (Fig. 1). The baseline data were collected in a controlled laboratory situation from volunteer airmen following a standard "8-5" regime (5). They were awakened for the 2400 and 0400 test times. The rhythmic 24-hour pattern seen in Figure 1 is very reliable, and correlates well with 24-hour physiological rhythms. Comparison to the baseline data amplifies the downward trend of the RIVET JOINT data. Typically, feelings of subjective fatigue decrease from morning to midafternoon; however, as the RIVET JOINT mission progressed through this interval of the day, the amount of subjective fatigue <u>increased</u>.

TABLE 1. SUMMARY OF "RIVET JOINT" SLEEP AND SUBJECTIVE FATIGUE DATA

Average hours slept during 20 hours (0600-0200) preceding mission	7.3 hours
Average hours slept during last sleep period prior to mission	4.5 hours
Percent crewmen having difficulty going to sleep prior to mission	75%
Percent crewmen feeling only slightly to moderately rested prior to mission	85%
Percent crewmen desiring more sleep prior to mission	75%

Average subjective fatigue scores

0200 (preflight)	10.4
0600	9.5
0900	9.0
1200	8.0
1500	7.5

Studies of operational teams performing a similar mission are also available for comparison purposes. Data from National Emergency Airborne Command Post (NEACP) missions were collected (1) during an extended practice alert (NIGHT STAR) in May 1973. The mission teams were comprised of 17 crewmen who performed activities similar to those of RIVET JOINT. The NEACP missions were flown on an EC-135; thus, the general aircraft environment was also similar to RIVET JOINT missions. One of the NEACP teams performed their first NIGHT STAR mission over approximately the same interval of time (Fig. 1) as that of the present RIVET JOINT mission. The NEACP mission lasted about 9 hours, the RIVET JOINT about 11. Both missions promoted significant increased feelings of fatigue. During the NEACP mission, the percent change from start to finish was greater (33%) than for RIVET JOINT (20%). The initial mean airborne fatigue score for the RIVET JOINT crewmen was considerably lower (indicating greater fatigue) than for the NEACP team, probably for two closely related reasons. First, the RIVET JOINT crewmen awakened at around 2400, some 5 hours before takeoff; the NEACP team awakened only 2-3 hours before takeoff. Second, the NEACP team slept an average of 6.2 hours immediately before reporting; the RIVET JOINT crewmen only 4.5 hours. Both of these factors contribute to partial sleep deprivation, a main contributor to acute and cumulative fatigue.

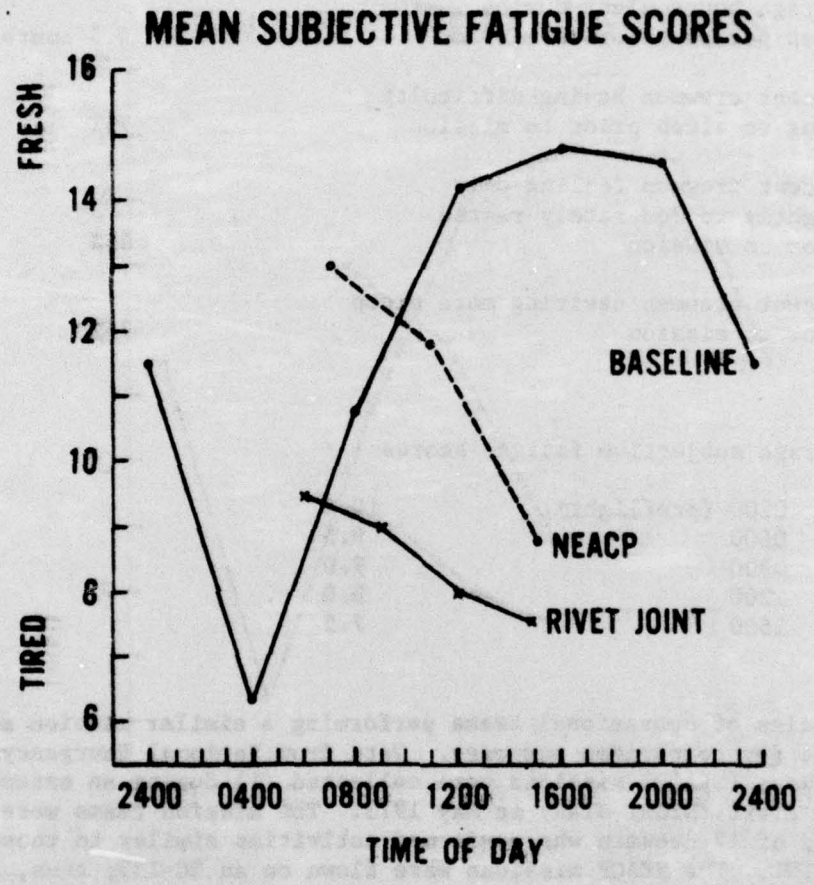

Figure 1. Comparison of RIVET JOINT fatigue scores with standard baseline and similar operational (NEACP) data. The NEACP mission was airborne from approximately 0630-1530. The RIVET JOINT mission was airborne from 0500-1600.

It is important to bear in mind that the RIVET JOINT data being presented are from only one mission. The subjective fatigue and sleep-log data collected during other RIVET JOINT missions flown at other times of day will be different. From the present data, however, some operational implications are suggested. Following participation in a RIVET JOINT mission of this time/duration profile, crewmen should be permitted a minimum of 12 hours rest and sleep. Since mission termination occurs in late afternoon, advantage can be taken of the normal upcoming nighttime sleep period. Inadequate recovery from such a mission could have significant undesirable cumulative effects on performance in subsequent missions, no matter what the time of day.

Finally, many of the crewmen volunteered comments about the inability to attain good quality sleep during the afternoon and early evening hours preceding the mission. Improving the quality of sleeping quarters (noise, humidity, and temperature) would seem to greatly ameliorate the fatigue reported at preflight check-in and early in the mission.

As stated at the beginning of this report, the purpose of administering this test was to refine procedures and analytical techniques for their implementation during the demonstration/evaluation of the modernized RIVET JOINT system. Data samples were obtained from a single flight and therefore are insufficient for establishing specific conclusions concerning the physiological or psychological costs. The real results of the test were that only minor changes to the procedures and techniques are necessary and that a valuable baseline has been obtained from which valid conclusions will be established for the modernized system.

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